Notes ichtyologiques / *Ichthyological notes*

The family Moridae (Gadiformes) from the Cape Verde Islands (eastern-central Atlantic Ocean), with first record of *Physiculus cyanostrophus*

by

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RÉSUMÉ. - La famille des Moridae (Gadiformes) des îles du Cap Vert (océan Atlantique centre-oriental), avec un premier signalement de *Physiculus cyanostrophus*.

Une liste des Moridae présents aux îles du Cap Vert est fournie. *Physiculus cyanostrophus* Anderson & Tweddle, 2002, ainsi qu'une possible nouvelle espèce de ce genre sont signalées pour la première fois aux îles du Cap Vert, portant à six le nombre de moridés signalés dans la zone. La présence de *Gadella imberbis* (Vaillant, 1888) est confirmée pour cet archipel. Les données disponibles sur la répartition, l'habitat, la morphométrie et la reproduction sont présentées, et une clé d'identification pour les genres et espèces de moridés présentes aux îles du Cap Vert et mers adjacentes est fournie. *Laemonema laureysi* Poll, 1953 est le moridé capverdien le plus abondant. Étant donné son abondance, sa taille et la qualité de sa chair, il pourrait avoir un intérêt commercial dans un futur proche.

Key words. - Moridae - *Physiculus cyanostrophus* - *Gadella imberbis* - *Laemonema laureysi* - ANE - Cape Verde Islands - First record.

Morids are benthopelagic to pelagic, deep-water gadiform fishes ranging from shallow coastal areas to deep waters beyond 2500 m. Morid cods, also called moras, are represented by 18 genera and at least 111 species distributed around the world. Of these, 12 genera and 37 species are found in the Eastern Atlantic Ocean and the Mediterranean Sea (Cohen *et al*., 1990; Froese and Pauly, 2008).

Until the present paper, only four species of morids have been recorded from the Cape Verde Islands (Fig. 1): *Gadella imberbis* (Vaillant, 1888), *Laemonema laureysi* Poll, 1953, *Laemonema robustum* Johnson, 1862 and *Physiculus dalwigki* Kaup, 1858 (Vaillant, 1888; Fowler, 1936; Poll, 1953; Reiner, 1996, 2005; González *et al*., 2004; Menezes *et al*., 2004).

Following two deepwater surveys off the Cape Verde Islands, *Physiculus cyanostrophus* Anderson & Tweddle, 2002 (Fig. 2) was recorded for the first time, as well as a possible new species of this genus. Additional biological data on other morids caught are also given.

MATERIAL AND METHODS

Two fish trapping surveys of the epibenthic and benthic fauna of the Cape Verde Islands between 100 m and 1000 m of depth were carried out off the islands of Boa Vista and Santiago (including the Bancona Bank) (Fig. 1). All the specimens studied were caught during these two cruises on board the research vessels of the Instituto Canario de Ciencias Marinas: R/V 'Taliarte' (August 10-23, 2003) and R/V 'Pixape II' (June 4-16, 2005).

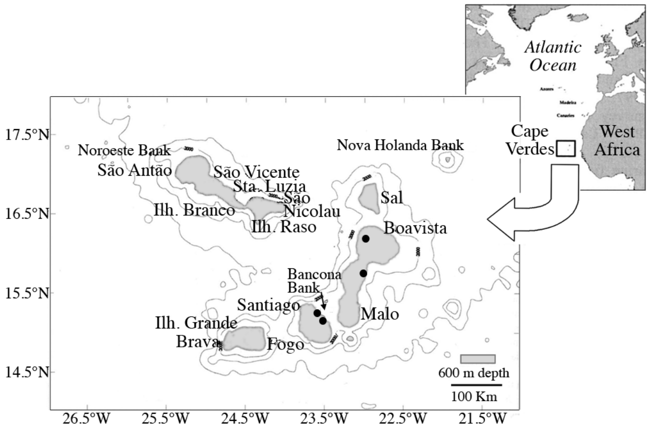

Figure 1. - The archipelago of Cape Verde. Collection locations (●).

The following fishing gear was used: bottom traps (BT) and semifloating traps (SFT, operated around 3 m above the seafloor) (González *et al*., 1992, 2004). Four depth strata (100-300, 300-500, 500-700, and 700-1000 m) were surveyed with both BT and SFT. On average, all traps were deployed for 16-18 h. Baits used were salted Atlantic chub mackerel (*Scomber colias*) in BT and frozen chicken thighs in SFT.

A total of 272 and 258 valid fishing operations were done during cruises 'Taliarte 2003-08' and 'Cabo Verde 2005-06', respectively; the sampling effort was evenly distributed in terms of depth and geographical sectors.

Voucher specimens were deposited in the collections of the Museu Municipal do Funchal (História Natural) (MMF), the Museo de Ciencias Naturales de Tenerife (TFMC), and the Instituto Canario de Ciencias Marinas (ICCM). Additional unpreserved material was included in the present account whenever relevant for depth range or biological information.

Measurements (in millimetres) and counts were made following Trunov (1989) and Paulin (1989). Abbreviation used in table I: InV-af - distance between the interventral line and the anal-fin origin.

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Cybium 2010, 34(2): 217-221.

Table I. - Selected counts and body proportions of *Physiculus cyanostrophus*.

	3 specimens (Present study)	12 specimens (Anderson and Tweddle, 2002)
Standard length (SL mm)	206-295	115-278
In %SL		
Head length (HL)	22.7-23.1	21.7-24.4
Interorbital width	4.9-5.1	4.1-4.8
Pectoral fin length	15.4-18.0	15.4-17.9
Greatest body depth	17.2-20.3	17.6-20.2
Snout length	4.4-5.0	3.6-4.8
Eye diameter	4.1-5.6	4.9-6.4
In %HL		
Snout length	19.4-21.7	15.6-20.6
Eye diameter	16.7-24.6	22.2-27.8
Interorbital width	21.3-22.4	18.8-21.4
Barbel length	3.9-4.5	4.2-9.2
In %InV-af		
Distance between interventral line and anterior margin of light organ	37.1-38.5	31.0-39.7
Distance from posterior margin of light organ to anterior margin of anus	23.8-25.8	23.6-28.5
Counts		
First dorsal-fin rays	8	8-9
Second dorsal-fin rays	69-72	65-70
Anal-fin rays	68-74	71-76
Pectoral-fin rays	19-26	22-23
Pelvic-fin rays	7	5-6
Filamentous pelvic rays extending to	8-9th anal ray	no data
Caudal-fin rays	22-27	25-28
Scales in longitudinal series	+105	ca. 126-130
Scales between first dorsal fin base and lateral line	9-10	8
Gill rakers on upper limb	4	3-5
Gill rakers on lower limb	10	9-11
Total gill rakers	14	13-16
Branchiostegal rays	7	7
Teeth		
Teeth on mouth	villiform, equal-sized	villiform, equal-sized
Teeth on vomer and palatines	absent	absent

RESULTS

Gadella imberbis (Vaillant, 1888)

Material examined. - MMF 39285, 338 mm TL, 304 mm SL, 15°28'N 23°26'W, Bancona Bank, northeast of Santiago, 300-400 m, cruise Cabo Verde 2005-06, sta. 140, 13 Jun. 2005, BT.

Remarks. - An amphi-Atlantic species rather widespread in the Caribbean and subtropical-tropical western Atlantic (from 41°N, Canada to 34°S, Brazil), apparently more restricted in the tropical eastern Atlantic, where it is found from the Cape Verde to Namibia (Scott and Scott, 1988; Cohen, 1990; Cohen *et al*., 1990; Bianchi *et al*., 1999; Froese and Pauly, 2008), including the Walvis Ridge at 18°23'S (Trunov, 1992). Benthopelagic on the outer shelf and upper slope at depths ranging from 200 to 800 m (Cohen *et al*., 1990; Froese and Pauly, 2008), mainly between 230 and 500 m depth on sandy mud or sand substrates in 7-14°C water temperatures along the west African coast (Poll, 1953, as *Uraleptus maraldi*). It was first recorded from the Cape Verde Islands (type locality) by Vaillant (1888, p. 293, Pl. XXV, fig. 4, as *Brosmiculus imberbis*) based on two 159 mm TL specimens caught at 460 m. Our 338 mm TL specimen was caught at 300-400 m and is apparently the largest specimen ever recorded (maximum size, 230 mm TL according to Cohen *et al*. (1990) and Froese and Pauly (2008)). This finding is the second record of this species from the Cape Verde Islands, the northernmost limit for *Gadella imberbis* in the eastern Atlantic.

Laemonema laureysi Poll, 1953

Material examined. - TFMC-VP/01583, 315 mm TL, 292 mm SL, TFMC-VP/01584, 311 mm TL, 281 mm SL, MMF36381, 279 mm TL, 249 mm SL, and MMF 36382, 274 mm TL, 250 mm SL, 15°56'N 22°40'W, Ponta Medronha, Boa Vista, 559-603 m, cruise Cabo Verde 2005-06, sta. 78, 9 Jun. 2005, BT.

Additional material. - Cruise Taliarte 2003-08, 54 specimens, 245-360 mm TL, 305-745 m, BT: 2 spms, 310-312 mm TL, 443-460 m, sta. 35, and 13 spms, 247-251 mm TL, 570 m, sta. 37, Baía da Salina, Boa Vista, 13

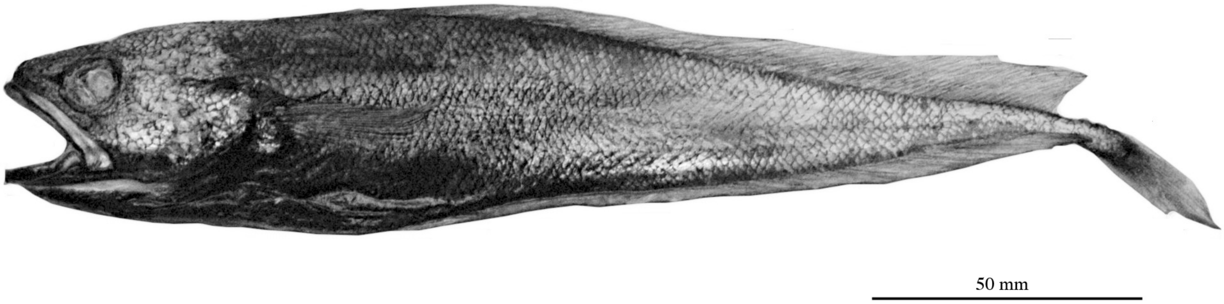

Figure 2. - *Physiculus cyanostrophus* from the Cape Verde Islands (MMF 39445, 231 mm TL, 206 mm SL, Baía do Tarrafal, Santiago, 174-175 m).

Aug. 2003; 2 spms, 310-312 mm TL, east of Ponta Antónia, Boa Vista, 530-575 m, sta. 51, 13 Aug. 2003; 4 spms, 248-252 mm TL, Ponta Rife Baluarte, Boa Vista, 420-450 m, sta. 71/73, 14 Aug. 2003; 5 spms, 246-253 mm TL, 420-460 m, sta. 87/89, and 2 spms, 315-320 mm TL, 580-600 m, sta. 93, south of Ponta do Roque, Boa Vista, 16 Aug. 2003; 1 spm, 300 mm TL, Ponta Medronha, Boa Vista, 500 m, sta. 103, 15 Aug. 2003; 2 spms, 245-250 mm TL, 400 m, sta. 111, and 2 spms, 301-303 mm TL, 540-650 m, sta. 115, east of Ponta Taráfe, Boa Vista, 15 Aug. 2003; 2 spms, 315-320 mm TL, west of Ponta Taráfe, 400-500 m, sta. 127, 16 Aug. 2003; 1 spm, 305 mm TL, Ponta Lacação, Boa Vista, 600-630 m, sta. 139, 17 Aug. 2003; 1 spm, 307 mm TL, 400-584 m, sta. 151, and 1 spm, 309 mm TL, 690-800 m, sta. 155, Ponta Varandinha, Boa Vista, 17 Aug. 2003; 1 spm, 246 mm TL, 260-350 m, sta. 167, 6 spms, 248-260 mm TL, 400-460 m, sta. 183/185, and 1 spm, 263 mm TL, 1 ripe female, 245 mm TL, and 2 spent females, 325-360 mm TL, 550-650 m, sta. 187, Bancona Bank, northeast of Santiago, 18 Aug. 2003; 1 male, 315 mm TL, Baía do Tarrafal, Santiago, 450 m, sta. 215, 19 Aug. 2003; 1 spm, 310 mm TL, Ponta Covinha, Santiago, 510-520 m, sta. 235, 20 Aug. 2003; 1 ripe female, 335 mm TL, 440 m, sta. 263/266, and 1 spm, 335 mm TL, and 1 spent female, 335 mm TL, 530-587 m, sta. 267/268, Ponta do Lobo, Santiago, 21 Aug. 2003. Cruise Cabo Verde 2005-06, 69 spms, 117-372 mm TL, 295-732 m, BT: 1 spm, 320 mm TL, Ponta do Sol, Boa Vista, 295-299 m, sta. 1, 5 Jun. 2005; 11 spms, 195-345 mm TL, Ponta do Sol, 402-506 m, sta. 5/7, 5 Jun. 2005; 1 spm, 235 mm TL, and 1 mature female, 263 mm TL, Ponta do Sol, 620-732 m, sta. 10, 5 Jun. 2005; 1 spm, 305 mm TL, Baía de Sal Rei, Boa Vista, 447-492 m, sta. 25, 6 Jun. 2005; 4 spms, 160-285 mm TL, Ponta Rife Baluarte, Boa Vista, 458-487 m, sta. 56/58, 8 Jun. 2005; 1 spm, 120 mm TL, Ponta Medronha, Boa Vista, 350-406 m, sta. 76, 9 Jun. 2005; 10 spms (including 1 resting male and 1 resting female), 125-300 mm TL, Bancona Bank, northeast of Santiago, 340-400 m, sta. 140/142, 13 Jun. 2005; 4 spms (including 1 early mature male and 1 mature female), 296-338 mm TL, Bancona Bank, 340-344 m, sta. 156/158, 13 Jun. 2005; 3 resting and 1 mature female, 320-357 mm TL, Bancona Bank, 530-610 m, sta. 146, 13 Jun. 2005; 3 spms, 232-359 mm TL, Baía do Tarrafal, Santiago, 580-593 m, sta. 176, 14 Jun. 2005; 6 spms, 128-334 mm TL, Baía do Tarrafal, 460-495 m, sta. 188/190, 14 Jun. 2005; 2 spms, 296-372 mm TL, Ponta Covinha, Santiago, 477-544 m, sta. 204, 15 Jun. 2005; 3 spms, 304-319 mm TL, Ponta Covinha, 525-530 m, sta. 208/210, 15 Jun. 2005; 6 spms, 117-340 mm TL, Ponta Covinha, 388-432 m, sta. 220/222, 15 Jun. 2005; 3 spms (including 1 resting and 1 mature female), 339-355 mm TL, Ponta Covinha, 600-659 m, sta. 224/226, 15 Jun. 2005; 8 spms, 195-340 mm TL, Ponta da Achada da Baleia, Santiago, 555-575 m, sta. 240/242, 16 Jun. 2005.

Remarks. - A tropical eastern Atlantic species, known from 17.5ºN (Cape Verde Islands) to at least 20º16'S (northern shores of Namibia), bathydemersal on the outer shelf and upper slope at depths ranging from 200 to 850 m (Trunov, 1989; Cohen, 1990; Cohen *et al*., 1990; Sanches, 1991; Menezes *et al*., 2004; Froese and Pauly, 2008), mainly deeper than 300 m on sandy mud substrates at 7-9.4ºC water temperatures along the west African coast (Poll, 1953; Trunov, 1989). It was apparently recorded for the first time from the Cape Verde Islands by Reiner (1996). According to this author (1996, 2005) it is a poorly known species in the Cape Verde. In a bottom longline survey carried out by the R/V *Arquipélago*, many specimens (270-430 mm TL) were frequently caught at several Cape Verdean islands, islets and seamounts, between 300 and 850 m, but usually at 350-700 m (Menezes *et al*., 2004). Our captures confirm the common occurrence of this species off this archipelago, where it seems to be the most abundant morid and probably of potential commercial interest. All specimens were caught with bottom traps at depths between 295 m and 745 m, chiefly at 350-600 m (87% of collections) and reproductive activity in both sexes was observed in June and August.

Laemonema robustum **Johnson, 1862**

Material examined. - None.

Remarks. - A deep-water species ranging from 336 to 1200 m depth and widely distributed around oceanic islands in the Atlantic and Pacific oceans (Meléndez and Markle, 1997). It has been recently recorded from the Hawaiian Archipelago (Mundy, 2005). In the eastern Atlantic it is known from Madeira (type locality), the Canaries (González *et al*., 2008), the Cape Verde Islands (Menezes *et al*., 2004), and St. Helena (Edwards, 1990). The records from off Agadir, Morocco and Cape Verde (Vaillant, 1888) may pertain to another species (Maul, 1952; Biscoito and Maul, 1989). Menezes *et al*. (2004) record is based on one specimen caught off Santo Antão at 800-850 m and measuring 430 mm TL, apparently the largest ever recorded.

Physiculus cyanostrophus **Anderson & Tweddle, 2002 (Fig. 2)**

Material examined. - Cruise Cabo Verde 2005-06, 15º14'N 23º45'W, Baía do Tarrafal, Santiago, 14 Jun. 2005, BT: ICCM 120, 326 mm TL, 295 mm SL, 195-220 m, sta. 170; ICCM 121, 246 mm TL, 221 mm SL, and MMF 39445, 231 mm TL, 206 mm SL, 174-175 m, sta. 186.

Remarks. - A mid-shelf to upper-slope species, recently described and up to the present only known from the holotype and paratypes, caught with bottom trawl off Angola (12º15'-12º26'S) between 111 m and 326 m of depth (12 specimens, range 115-278 mm SL) (Anderson and Tweddle, 2002). Our specimens are the second collection of this apparently rare species and the first record from the Cape Verde Islands, caught between 174 and 220 m of depth.

Selected counts and measurements of the material examined are given in table I and compared with Anderson and Tweddle's (2002) data. The specimen ICCM 120 (295 mm SL, 326 mm TL) is the largest ever caught. According to those authors, *P. cyanostrophus* shows a dark metallic-blue band encircling anterior half of body, has the posterior half of body pink with slight bluish tinge and all fins reddish (live colouration). The Cape Verde specimens match this striking colour pattern.

Physiculus dalwigki **Kaup, 1858**

Material examined. - None.

Remarks. - An outer-shelf to upper-slope species ranging from ca. 100 m (Cohen *et al*., 1990) to 742 m depth (Merrett and Domanski, 1985). Known from the western Mediterranean and Eastern Atlantic, from Morocco, Western Sahara, and Mauritania to 20°45'N (Paulin, 1989; Cohen, 1990), including the Azores (Santos *et al*., 1997), Madeira, Great Meteor Bank, the Canaries (Vaillant, 1888; Merrett and Domanski, 1985; Cohen, 1990; Cohen *et al*., 1990; Brito *et al*., 2002; González *et al*., 2008), the Cape Verde Islands (Reiner, 1996; Menezes *et al*., 2004), and St. Helena (Günther, 1862). According to Menezes *et al*. (2004), this is a common species off the Cape Verde, being caught off São Vicente and Fogo islands (290-300 mm TL) at 350-700 m of depth. However, no specimens were collected during our two trapping surveys.

Physiculus **sp.**

Material examined. - Cruise Cabo Verde 2005-06, 16º19'N 23º03'W, Ponta do Sol, Boa Vista, 420-506 m, 5 Jun. 2005, BT: MMF 39704, 254 mm TL, 232 mm SL, sta.7; MMF 39705, 226 mm TL, 207 mm SL, sta.5; MMF 39706, 230 mm TL, 212 mm SL, sta.5.

Remarks. - Body proportions and meristics, including X-ray vertebral counts do not match with descriptions of any of the known *Physiculus* species occurring in the tropical and subtropical Atlantic Ocean: *P. capensis, P. cyanostrophus, P. dalwigki, P. helenaensis, P. huloti, P. karrerae, P. kaupi* and *P. maslowskii*. These specimens may belong to a still undescribed species and an in-depth taxonomical study is being done, the results of which will be published elsewhere.

DISCUSSION

Only three genera and six species of the family Moridae occur off the Cape Verde Islands, representing 25% and 16%, respectively, of the known genera and species of morid cods in the eastern Atlantic Ocean and the Mediterranean Sea. This low diversity may, among other natural factors, be due to lack of research at appropriate depths and with appropriate fishing gear. The recent most-extensive surveys have used only bottom longlines (Menezes *et al*., 2004) and baited traps (this account), and both have not exceeded 1200 m depth.

Physiculus cyanostrophus seems to be the shallowest Cape Verdean morid, inhabiting the outer-shelf (174-220 m) and probably the upper-slope (111-326 m off Angola). The other morids from the Cape Verde Islands are deep-water species, distributed along the islands' slopes, from about 300 m down to at least 850 m: *Laemonema laureysi* (295-850 m, but mainly at 350-600 m), *Gadella imberbis* (300-460 m), *Physiculus dalwigki* (350-700 m), *Physiculus* sp. (420-506 m) and *Laemonema robustum* (800-850 m).

It is highly expected that *Antimora rostrata* (Günther, 1878) will be found in the Cape Verde if deeper waters are surveyed, as it has been recently found in the Canary Islands below 1700 m (González *et al*., 2008) and is also present along the African slope, off Congo and southern Africa (Cohen *et al*., 1990). On the other hand, strikingly absent are *Gadella svetovidovi* Trunov, 1992 and *Physiculus huloti* Poll, 1953. The former has been caught in the Canaries well within the depth range of the Cape Verdean surveys (González *et al*., 2008) as well as further south at Walvis Ridge (Trunov, 1992), and the latter is present in the eastern tropical Atlantic, e.g. in Angola, Congo (Poll, 1953), and Guinea Bissau (Sanches, 1991).

In terms of occurrence, *L. laureysi* was by far the most abundant morid species in our trap surveys (more than 125 specimens). It was also considered frequent by Menezes *et al*. (2004) with bottom longlines. The other species of this family were not represented by more than 3 specimens in more than 500 trap hauls over 125 locations in two different islands and seasons, which may reflect their rarity in the area. *P. dalwigki* was considered common by Menezes *et al*. (2004), but was not collected in our baited traps, which puts in evidence a remarkable difference in terms of specific selectivity of the fishing gear used.

Amongst the morids found in the Cape Verde Islands, *Laemonema laureysi*, due to its abundance, size (up to 43 cm TL) and flesh quality, may eventually be of commercial interest as by-catch in a future small-scale trap fisheries for the striped soldier shrimp *Plesionika edwardsii* (Brandt, 1851) and deep-sea red crab *Chaceon affinis* (A. Milne-Edwards & Bouvier, 1894) off the islands, islets and banks of the vast EZZ of the Cape Verde archipelago.

Identification key to morid genera and species occurring off the Cape Verde Islands and adjacent seas

1a. Snout depressed to form a broadly V shaped plate .... *Antimora rostrata*

1b. Snout not as above

2a. Ventral light organ present. Pelvic fins composed of more than two well developed rays

3a. Chin barbel present. Teeth lacking on vomer ...... *Physiculus*

4a. Teeth equal or subequal, not in a graded series

5a. First dorsal fin rays 10-12; second dorsal fin rays 53-57; anal fin rays 57-62; gill rakers 3+6-8; oblique scale rows between first dorsal fin and lateral line 10-12; scales in longitudinal series ca. 100-108; total vertebrae 46-48 .... *Physiculus huloti*

5b. First dorsal fin rays 8-9; second dorsal fin rays 65-72; anal fin rays 68-76; gill rakers 3-5+9-11; oblique scale rows between first dorsal fin and lateral line 8-10; scales in longitudinal series ca. 126-130; total vertebrae 49-59 .... *Physiculus cyanostrophus*

4b. Teeth in a graded series

6a. Oblique scale rows between first dorsal fin and lateral line 11-13; scales in longitudinal series ca. 119-126; total vertebrae 52-55; first dorsal fin rays 6-9; second dorsal fin rays 63-68; anal fin rays 66-75; gill rakers 2-3+7-9 .... *Physiculus dalwigki*

6b. Oblique scale rows between first dorsal fin and lateral line more than 15; scales in longitudinal series more than 135 .... *Physiculus* sp.

3b. Chin barbel absent .... *Gadella*

7a. Second dorsal fin rays 63-67; anal fin rays 68-73; oblique scale rows between first dorsal fin and lateral line 10-12; the pelvic fins reach only to the anterior edge of the base of the anal fin; 2 rows of sharp, fanglike teeth on the upper jaw ....*Gadella svetovidovi*

7b. Second dorsal fin rays 51-61; anal fin rays 55-66; oblique scale rows between first dorsal fin and lateral line 6-8; the pelvic fins reach to the base of the fourth anal fin ray; 2 rows of smaller, more closely set teeth on the upper jaw .... *Gadella imberbis*

2b. Ventral light organ lacking. Anal fin not notably indented. Pelvic fin composed of two well developed long rays (sometimes with several rudimentary rays at the base) . . . . *Laemonema*

8a. Second dorsal fin rays 68-69; anal fin rays 64-67; pectoral fin rays 21-21; gill rakers 6-8+17-20 . . . . *Laemonema laureysi*

8b. Second dorsal fin rays 48-59; anal fin rays 43-54; pectoral fin rays 26-30; gill rakers 4-6+13-16 . . . . *Laemonema robustum*

Acknowledgements. - The authors are indebted to José A. Pérez-Peñalvo, Sergio Ramos, Olga Ayza and Mikel Arrasate for skilful technical assistance. Thanks are also due to Dr. Luis Felipe López-Jurado, Ing. Óscar D. Melício, and the masters and crews of the research vessels used. Logistic and financial support was received from the Instituto Nacional de Desenvolvimento das Pescas – Cabo Verde, the Government of the Canary Islands and the EU ERDF in the framework of the PIC INTERREG III B project Hydrocarpo (MAC/4.2/C5).

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Reçu le 25 juin 2009.
Accepté pour publication le 4 septembre 2009.